(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 840 395 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.05.1998 Bulletin 1998/19

(51) Int. Cl.[6]: **H01Q 13/20**, H04B 5/00

(21) Application number: **97119063.2**

(22) Date of filing: **31.10.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV RO SI

(30) Priority: **31.10.1996 JP 290930/96**

(71) Applicant:
SUMITOMO WIRING SYSTEMS, LTD.
Yokkaichi City Mie 510 (JP)

(72) Inventors:
- **Tamura, Yoshihiro,**
  c/o Sumitomo Wiring Syst. Ltd.
  Yokkaichi-City, Mie (JP)
- **Sasagawa, Masao,**
  c/o Sumitomo Wiring Syst. Ltd.
  Yokkaichi-City, Mie (JP)
- **Tsuchizaki, Yoshio,**
  c/o Sumitomo Elec. Ind. Ltd.
  Konohana-ku, Osaka-shi, Osaka (JP)
- **Mita, Kyouji,**
  c/o Sumitomo Elec. Ind. Ltd.
  Konohana-ku, Osaka-shi, Osaka (JP)

(74) Representative:
Müller-Boré & Partner
Patentanwälte
Grafinger Strasse 2
81671 München (DE)

(54) An insulated conductor pair and a guide cable using the same

(57) To provide a layered insulated conductor pair which can be easily manufactured in inexpensive facilities and with which a highly precise and stable degree of electromagnetic coupling can be obtained, and a guide cable using such a layered insulated conductor pair.

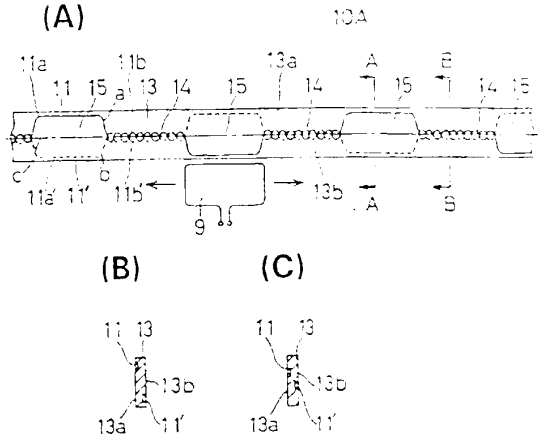
A layered insulated conductor pair 10A includes a plurality of film-shaped insulators 13, 13' placed one over another, and each insulator has line conductors 11, 11' of specified shape fixed to its front surface or its inside.

A layered insulated conductor pair 10B includes a film-shaped insulator having line conductors 11, 11' of specified shape fixed to its front surface or its inside.

A layered insulated conductor pair 10C includes electromagnetic screening layers 20 arranged at intervals in close contact with the conductors 11, 11'.

A guide cable includes one or more layered insulated conductor pairs 10A to 10C which are formed into a single piece and are surrounded by an outer coating 18.

FIG. 1



EP 0 840 395 A2

Description

The present invention relates to an insulated conductor pair and a guide cable using the same.

Conventionally, in order to effect a communication between a movable body such as a vehicle moving along a railway track or road and a ground station, a so-called guide or leaky cable is laid along the track or road and a bidirectional communication is effected to transmit and receive an information to and from each other by coupling an electromagnetic field leaking in a suitable degree from this guide cable with an antenna provided on the movable body.

As another application, an electromagnetic field may be caused to not continuously, but intermittently leak from the guide cable, and distances between the positions where the electromagnetic field leaks and the ground station may be accurately measured and gauged. Then, the position of the movable body from the ground station can be accurately monitored and grasped based on the reaction of the movable body to a signal transmitted from the ground station or a phase difference of a signal transmitted from the movable body and received by the ground station via the guide cable.

Because of the above application, the guide cable is also called a movable body position detecting guide cable.

The above guide cable is, as shown in FIG. 8, formed such that two insulated wires 3, 3' each comprised of a conductor 1 and an insulating coating 2 are twisted in one direction to form an insulated wire pair 4 and an electromagnetic field coupling portions (opened portions) 5 where the insulated wires 3, 3' are parallelly spaced from each other are formed at intervals along the length of the insulated wire pair 4.

The thus formed guide cable 7 is usually called a twisted pair type guide cable.

As shown in FIGS. 9(A) and 9(B), the guide cable 7 is constructed such that a guide pair formed by the insulated wire pair 4 arranged on a base plate 8 is pressingly taped together with an interposition member for holding the configuration of the guide pair and protecting the guide pair against an external force, and the taped guide pair is further surrounded by an outer coating made of a nonmetallic and nonmagnetic (for an efficient leakage of an electromagnetic field) synthetic resin such as polyolefin or vinyl chloride.

Portions of the guide cable 7 at the opposite sides of the electromagnetic field coupling portions 5 where the insulated wires 3, 3' are twisted are electromagnetic field uncoupling portions 6, which have a property of leaking an electromagnetic field in a very small degree as compared with the electromagnetic coupling portions 5 by the twist effect of the insulated wires 3, 3'.

Accordingly, as shown in FIG. 10, when an antenna 9 of the movable body moves along the guide cable 7, an antenna coupling output becomes larger when the antenna 9 approaches the electromagnetic field coupling portion 5 while becoming smaller when the antenna 5 approaches the electromagnetic field uncoupling portion 6.

Facilities for manufacturing the insulated wire pair 4 of the guide cable 7 are usually as follows. Reels on which the insulated wires 3, 3' are wound up are mounted on a rotary feeding apparatus. The insulated wires 3, 3' let out from the respective reels are guided by wire guides to a twisting die while the rotary feeding apparatus and the respective reels are rotated. The insulated wire pair 4 is withdrawn from the twisting die by being held between belts of a withdrawing apparatus while stopping the rotation. In this way, the insulated wire pair 4 twisted in one direction is formed and taken up by a drum of a take-up apparatus.

The insulated wire pair 4 taken up by the drum of the take-up apparatus is let out from this drum by a suitable length, and the insulated wires 3, 3' are untwisted at intervals along the length of the insulated wire pair 4 and arranged in parallel. By widening the spacing between the untwisted portions of the insulated wires 3, 3' in parallel with each other, the electromagnetic field coupling portion 5 is provided.

However, the conventional twisted pair type guide cable 7 using the insulated wire pair 4 requires large manufacturing facilities since two insulated wires 3, 3' are twisted to manufacture the insulated wire pair 4. Further, in order to improve the accuracy of twisting intervals of the insulated wires 3, 3' which directly influences the antenna coupling output, the manufacturing facilities need to be highly precisely controlled. Accordingly, there are problems of the large facilities and high running costs.

An operation of providing the electromagnetic field coupling portions 5 by untwisting the insulated wires 3, 3' at intervals along the length of the insulated wire pair 4, parallelly arranging the untwisted portions, and widening the spacing between the untwisted portions in parallel with each other is a very difficult operation which still requires a lots of time and labor despite the use of large-scaled machines and tools. It is also difficult to accurately space the insulated wires 3, 3' in parallel with each other in the electromagnetic field coupling portions 5, and the insulated wires 3, 3' are nonuniformly twisted and arranged in boundary portions between the electromagnetic field coupling portions 5 and the electromagnetic field uncoupling portions 6. As a result, a highly precise and stable degree of electromagnetic coupling is unlikely to be obtained.

Particularly, since the twisted insulated wire pair 4 has a circular cross section and is likely to rotate about its axis, the twisting intervals may vary due to the rotation of the insulated wire pair 4 about its axis upon being subjected to an external force while the insulated wire pair 4 is assembled into the guide cable.

Further, since the insulated wires 3, 3' having a circular cross section are used, the guide cable 7 has a large thickness (height). Accordingly, such a guide

cable 7 cannot be laid in a place which needs to be thin such as a floor surface, a wall surface or a narrow cable passage portion, and it is not possible to completely eliminate the leakage of the electromagnetic field by electromagnetically screening only portions corresponding to the electromagnetic uncoupling portions 6 of the guide cable 7.

The present invention was developed in view of the above problems, and an object thereof is to provide an insulated conductor pair which can be easily manufactured in inexpensive facilities and with which a highly precise and stable degree of electromagnetic coupling can be obtained, and a guide cable using such an insulated conductor pair.

This object is solved according to the invention by an insulated conductor pair according to claim 1 and by a guide cable according to claim 8. Preferred embodiments of the invention are subject of the dependent claims.

According to the invention, there is provided an insulated conductor pair , wherein the insulated conductor pair is layered and comprises at least one film-shaped insulator having one or more line conductors of specified shape fixed to its surface or its inside or embedded.

According to another aspect of the invention, there is provided a layered insulated conductor pair, characterized by comprising a plurality of film-shaped insulators placed one over another, each insulator having line conductors of specified shape fixed to its front surface or its inside.

With the above construction, unlike the prior art insulated wire pair in which insulated wires are twisted, the line conductors need not be twisted in the layered insulated conductor pair, thereby obviating the need for large-scaled manufacturing facilities and for a control apparatus for highly precisely controlling the manufacturing facilities.

Further, unlike the prior art insulated wire pair, a difficult operation of untwisting the portions of the insulated wires and spacing the untwisted portions in parallel with each other to provide the electromagnetic field coupling portions is not necessary. Further, since the line conductors can be easily and accurately fixed by, for example, being adhered to the film-shaped insulators, the line conductors can be more precisely spaced in parallel with each other in the electromagnetic field coupling portions and the boundary portions between the electromagnetic field coupling portions and the electromagnetic field uncoupling portions can be easily made uniform. Thus, a highly precise and stable degree of electromagnetic coupling can be obtained.

Further, since the layered insulated conductor pair neither rotates about its axis and requires twisting unlike the prior art insulated wire pair, a variation of a degree of electromagnetic coupling caused by a variation of twisting intervals is small.

Although the above layered insulated conductor pair is such that a plurality of film-shaped insulators are placed one over another, the same effects can be obtained even with the layered construction in which the line conductors are fixed to the opposite surfaces of one insulator.

According to a further aspect of the invention, there is provided a layered insulated conductor pair, comprising a film-shaped insulator having line conductors of specified shape fixed to its front surface or its inside.

Accordingly the layered insulated conductor pair has a simple, but precisely dimensioned construction in which the line conductors are fixed to the opposite sides of one insulator.

Preferably, each conductor comprises a plurality of divided or separated conductors, being preferably arranged in a rectangular or circular overall or outer cross section.

Accordingly, it can be thinned and easily bent as compared with the single large conductor.

Further preferably the spacing of the pair of conductors is varied at intervals along a longitudinal direction. Accordingly, the electromagnetic field coupling portions and the electromagnetic field uncoupling portions can be easily formed in the line conductors.

Most preferably, electromagnetic screening layers are arranged at intervals preferably in close contact with the conductors in the layered insulated conductor pair. Accordingly, when they are arranged particularly on the electromagnetic field uncoupling portions, the leakage of the electromagnetic field therefrom is prevented, making a difference between a degree of electromagnetic coupling between the electromagnetic field coupling portions and an antenna and the one between the electromagnetic field uncoupling portions and the antenna larger.

According to a further preferred embodiment, the line conductors are arranged such that first portions thereof are arranged along a substantially trapezoidal wave path having preferably a long cycle and second portions thereof are arranged along a sinuous path similar to a sine wave having preferably short cycles.

Preferably, the line conductors have a substantially circular or rectangular cross section.

According to the invention, there is further provided a guide cable being formed using one or more layered insulated conductor pairs according to the invention, which are integrally or unitarily formed or are formed into a single piece and are preferably surrounded by an outer coating. Accordingly, it can be thinned as compared with a guide cable using the prior art insulated wire pair. As a result, such a guide cable can be laid in a floor surface or like place where the thickness is desired to be reduced.

According to a preferred embodiment, the first portions of the line conductors correspond to an electromagnetic field coupling portion and wherein the second portions thereof correspond to an electromagnetic field uncoupling portion

Preferably, the electromagnetic screening layers are arranged at intervals preferably in close contact with the outer coating in the guide cable. Accordingly, even if they are not arranged in close contact with the conductors, the portions of the line conductors corresponding to the electromagnetic uncoupling portions can be electromagnetically screened to completely prevent the leakage of the electromagnetic field. Accordingly, a difference between a degree of electromagnetic coupling between the electromagnetic field coupling portions and the antenna and the one between the electromagnetic field uncoupling portions and the antenna can be made larger. In other words, the portions of the line conductors corresponding to the electromagnetic uncoupling portions can be electromagnetically screened to completely prevent the leakage of the electromagnetic field.

These and other objects, features and advantages of the present invention will become more apparent upon a reading of the following detailed description and accompanying drawings in which:

FIGS. 1(A) to 1(C) show a layered insulated conductor pair according to a first embodiment of the invention, wherein FIG. 1(A) is a front view, FIG. 1(B) is a section along A-A of FIG. 1(A) and FIG. 1(C) is a section along B-B of FIG. 1(A),

FIGS. 2(A) and 2(B) show two conductors of a layered insulated conductor pair according to a second embodiment, wherein FIG. 2(A) is a front view of one conductor and FIG. 2(B) is a front view of the other conductor,

FIGS. 3(A) to 3(C) show the layered insulated conductor pair according to the second embodiment, wherein FIG. 3(A) is a front view, FIG. 3(B) is a section along C-C of FIG. 3(A) and FIG. 3(C) is a section along D-D of FIG. 3(A),

FIG. 4 is a front view of a layered insulated conductor pair according to a third embodiment,

FIGS. 5(A) to 5(C) show the layered insulated conductor pair according to the third embodiment, wherein FIG. 5(A) is a section, FIG. 5(B) is a section along E-E of FIG. 5(A) and FIG. 5(C) is a section along F-F of FIG. 5(A),

FIGS. 6(A) and 6(B) are sections showing a first embodiment of a guide cable,

FIG. 7(A) is a section showing a second embodiment of a guide cable, and FIG. 7(B) is a section showing a third embodiment of the guide cable,

FIG. 8 is a front view of a prior art insulated wire pair,

FIGS. 9(A) and 9(B) are a front view and a section showing the prior art insulated wire pair, and

FIG. 10 is a graph showing an antenna coupling output along the longitudinal direction of the guide cable.

Hereafter, embodiments of the invention are described in detail with reference to the accompanying drawings.

FIGS. 1(A) to 1(C) show a layered insulated conductor pair 10A according to a first embodiment

Line conductors 11, 11' indicated by solid line a and broken line b as shown in FIG. 1(A) are leafs having a substantially rectangular cross section as shown in FIGS. 1(B) and 1(C). These line conductors 11, 11' are fixedly arranged on a front surface 13a and a rear surface 13b of an insulator 13 e.g. in the form of a thin film in a specifically sinuous manner, respectively.

Specifically, with reference to FIG. 2(A) showing a second embodiment, portions 11a of the line conductor 11 corresponding to electromagnetic field coupling portions 15 are preferably fixedly arranged on the front surface 13a of the insulator 13 along a substantially trapezoidal wave path having a long cycle, whereas portions 11b of the line conductor 11 corresponding to electromagnetic field uncoupling portions 14 are preferably fixedly arranged on the front surface 13a along a sinuous path similar to a sine wave having short cycles.

Similarly, with reference to FIG. 2(B), portions 11a' of the line conductor 11' corresponding to electromagnetic field coupling portions 15 are fixedly arranged on the rear surface 13b of the insulator 13 along a trapezoidal wave path having a long cycle, whereas portions 11b' of the line conductor 11' corresponding to electromagnetic field uncoupling portions 14 are fixedly arranged on the rear surface 13b along a sinuous path similar to a sine wave having short cycles.

The respective portions 11a, 11b, 11a', 11b' of the line conductors 11, 11' are arranged on the front and rear surfaces 13a, 13b of the insulator 13 such that their phases are inverted symmetrically with respect to a center line c.

The line conductors 11, 11' are imbedded in the front and rear surfaces 13a, 13b of the insulator 13 by insert molding. However, they may be adhered to the front and rear surfaces 13a, 13b by adhesive.

The planar portions 11a, 11b, 11a', 11b' of the line conductors 11, 11' are fixed to the front and rear surfaces 13a, 13b of the insulator 13, and are not twisted at all unlike the prior art insulated wire pair 4 using the insulated wires 3, 3'.

In the layered insulated conductor pair 10A according to the first embodiment, when viewed in a direction perpendicular to the plane of the film-shaped insulator 13, similar to the prior art guide cable using the insulated wire pair 4, the electromagnetic field coupling portions 15 where the conductors are parallelly spaced are provided at intervals along the length of the insulated conductor pair 10A, and the electromagnetic uncoupling portions 14 are provided between adjacent electromagnetic coupling portions 15.

The portions 11b, 11b' of the line conductors 11, 11' are not twisted in the electromagnetic field uncoupling portions 14 unlike the insulated wires 3, 3' in the electromagnetic uncoupling portions 6 of the prior art insulated wire pair 4. However, the portions 11b, 11b' arranged

along a sinuous path similar to the sine wave having short cycles are overlapped very close to each other. Accordingly, the electromagnetic field leaks in a small degree in a direction perpendicular to the thickness direction of the overlapped portions 11b, 11b'. Similar to the prior art electromagnetic uncoupling portions 6, the electromagnetic uncoupling portions 14 have a property of leaking the electromagnetic field in a very small degree.

FIGS. 2 and 3 show a layered insulated conductor pair 10B according to the second embodiment.

Line conductors 11, 11' indicated by solid line a and broken line b in FIG. 3(A) are leafs having a rectangular cross section as shown in FIGS. 3(B) and 3(C). These line conductors 11, 11' are fixedly arranged on a front surface 13a and a rear surface 13b of an insulator 13 and an insulator 13' in the form of a thin film in a specifically sinuous manner, respectively.

Specifically, as shown in FIG. 2(A), portions 11a of the line conductor 11 corresponding to electromagnetic field coupling portions 15 are fixedly arranged on the front surface 13a of the insulator 13 along a trapezoidal wave path having a long cycle, whereas portions 11b of the line conductor 11 corresponding to electromagnetic field uncoupling portions 14 are fixedly arranged on the front surface 13a along a sinuous path similar to a sine wave having short cycles.

Similarly, as shown in FIG. 2(B), portions 11a' of the line conductor 11' corresponding to electromagnetic field coupling portions 15 are fixedly arranged on the rear surface 13b of the insulator 13' along a trapezoidal wave path having a long cycle, whereas portions 11b' of the line conductor 11' corresponding to electromagnetic field uncoupling portions 14 are fixedly arranged on the rear surface 13b along a sinuous path similar to a sine wave having short cycles.

The respective portions 11a, 11b, 11a', 11b' of the line conductors 11, 11' are arranged on the front surface 13a of the insulator 13 and the rear surface 13b of the insulator 13' such that their phases are inverted symmetrically with respect to a center line c.

The respective line conductors 11, 11' are fixed or adhered to the front and rear surfaces 13a, 13b of the respective insulators 13, 13' by adhesive or the like.

The line conductors 11, 11' may be fixed or adhered to the front and rear surfaces 13a, 13b of one insulator 13 by adhesive or the like.

The insulators 13, 13' are adhered to each other by adhering the rear surface 13b of the insulator 13 and the front surface 13a of the insulator 13' by adhesive or the like so as to form a single piece insulator.

The planar portions 11a, 11b, 11a' and 11b' of the line conductors 11, 11' are fixed to the front surface 13a and the rear surface 13b of the insulators 13, 13', and are not twisted at all unlike the prior art insulated wire pair 4 using the insulated wires 3, 3'.

In the layered insulated conductor pair 10B according to the second embodiment, when the insulators 13, 13' are viewed in a direction perpendicular thereto, similar to the prior art guide cable using the insulated wire pair 4, the electromagnetic field coupling portions 15 where the conductors are parallelly spaced are provided at intervals along the length of the insulated conductor pair 10B, and the electromagnetic uncoupling portions 14 are provided between adjacent electromagnetic coupling portions 15.

The portions 11b, 11b' of the line conductors 11, 11' are not twisted in the electromagnetic field uncoupling portions 14 unlike the insulated wires 3, 3' in the electromagnetic uncoupling portions 6 of the prior art insulated wire pair 4. However, the portions 11b, 11b' arranged along a sinuous path similar to the sine wave having short cycles are overlapped very close to each other. Accordingly, similar to the prior art electromagnetic uncoupling portions 6, the electromagnetic field uncoupling portions 14 have a property of leaking the electromagnetic field in a very small degree.

FIGS. 4 and 5 show a layered insulated conductor pair 10C according to a third embodiment.

The layered insulated conductor pair 10C is basically constructed such that a difference between a degree of electromagnetic coupling between electromagnetic field coupling portions 15 and an antenna 9 and the one between electromagnetic field uncoupling portions 14 and the antenna 9 can be made larger, i.e. a difference between a coupling signal S of the electromagnetic field coupling portions 15 and a fine coupling signal (noise) N of the electromagnetic field uncoupling field 14 can be made larger using the layered insulated conductor pairs 10A, 10B according to the first and second embodiments.

More specifically, electromagnetic screening layers 20 made of a conductive or magnetic material or a composite of these materials are so arranged as to surround the respective electromagnetic field uncoupling portions 14 of the layered insulated conductor pair 10C or to be in sealable contact with the opposite surfaces of the electromagnetic filed uncoupling portions 14. In this way, the leakage of the electromagnetic field from the respective electromagnetic field uncoupling portions 14 to the outside is further prevented.

If necessary, insulating or reinforcing layers 21 may be arranged on or fixed thereto the outer surfaces of the respective electromagnetic screening layers 20.

Although the respective electromagnetic field coupling portions 15 are not provided with the electromagnetic screening layers 20 because of their purpose, in the case that a plurality of layered insulated conductor layers are placed one over another, the layers 20 may be provided in such a manner that the coupling of the electromagnetic field coupling portions 15 of one layered insulated conductor pair with the antenna 9 is not interfered by the layers 20 of the other layered insulated conductor pair(s). In such a case, the layers 20 need to have such size and configuration as not to cause the above interference.

FIGS. 6(A) and 6(B) are sections, corresponding to the FIGS. 3(A) and 3(B), showing an embodiment of a cable formed using the respective layered insulated conductor pairs 10A to 10C. It should be noted that a similar construction is adopted in the case that two or more layered insulated conductor pairs are formed into a single piece.

Protection layers 17 are arranged on the opposite surfaces of the layered insulated conductor pairs 10A to 10C, and such an assembly is surrounded by an outer coating 18.

The electromagnetic screening layers 20 may be arranged on the outer coating 18 instead of being arranged on the electromagnetic uncoupling portions 14 and the like as in the third embodiment.

Although the line conductors 11, 11' are leafs having a rectangular or square cross section in the respective foregoing embodiments, they may be each a conductor having a single circular cross section as shown in FIG. 7(A).

If the line conductors 11, 11' are each a conductor having a single circular cross section, they are easily and precisely bendable in a sinuous manner and connector terminals are easily connectable with the opposite ends thereof.

Further, as shown in FIG. 7(B), the line conductors 11, 11' may be each comprised of a plurality conductors having a small circular cross section.

If the line conductors 11, 11' are each comprised of a plurality of conductors having a small circular cross section, the thickness thereof can be reduced by eliminating an unnecessary space, and the rigidity of the line conductors 11, 11' as a layered insulated conductor pair against bending becomes smaller, with the result that the line conductors 11, 11' can be easily and precisely bent in a sinuous manner. The resistance of the line conductors 11, 11' against bend fatigue fracture caused by vibration while they are used is also improved.

LIST OF REFERENCE NUMERALS

10A to 10C	Layered Insulated Conductor Pair
11, 11'	Line Conductor
13, 13'	Insulator
13a	Front Surface
13b	Rear Surface
14	Electromagnetic Field Uncoupling Portion
15	Electromagnetic Field Coupling Portion
18	Outer Coating
20	Electromagnetic Screening Layer

Claims

1. An insulated conductor pair (10A; 10B; 10C), wherein the insulated conductor pair is layered and comprises at least one film-shaped insulator (13; 21) having one or more line conductors (11; 11') of specified shape fixed to its surface (13a) or its inside.

2. An insulated conductor pair according to claim 1 comprising a plurality of film-shaped insulators (13; 21) placed one over another, each insulator (13; 21) having the line conductors (11; 11') of specified shape fixed to its surface (13a) or its inside.

3. An insulated conductor pair according to one or more of the preceding claims, wherein each conductor (11; 11') comprises a plurality of divided conductors, being preferably arranged in a rectangular or circular overall cross section.

4. An insulated conductor pair according to one or more of the preceding claims, wherein the spacing of the pair of conductors (11; 11') is varied at intervals (14; 15) along a longitudinal direction.

5. An insulated conductor pair according to one or more of the preceding claims, wherein electromagnetic screening layers (20) are arranged at intervals (14), preferably in close contact with the conductors (11; 11').

6. An insulated conductor pair according to one or more of the preceding claims, wherein the line conductors (11; 11') are arranged such that first portions (11a; 11a') thereof are arranged along a substantially trapezoidal wave path having preferably a long cycle and second portions (11b; 11b') thereof are arranged along a sinuous path similar to a sine wave having preferably short cycles.

7. An insulated conductor pair according to one or more of the preceding claims, wherein the line conductors (11; 11') have a substantially circular or rectangular cross section.

8. A guide cable using one or more layered insulated conductor pairs (10A; 10B; 10C) according to one or more of the preceding claims which are integrally or unitarily formed and are preferably surrounded by an outer coating (18).

9. A guide cable according to claim 8 and claim 6, wherein the first portions (11a; 11a') of the line conductors (11; 11') correspond to an electromagnetic field coupling portion (15) and wherein the second portions (11b; 11b') thereof correspond to an electromagnetic field uncoupling portion (14).

10. A guide cable according to claim 8 or 9, wherein electromagnetic screening layers (20) are arranged at intervals (14), preferably in close contact with the outer coating (18).

FIG. 1

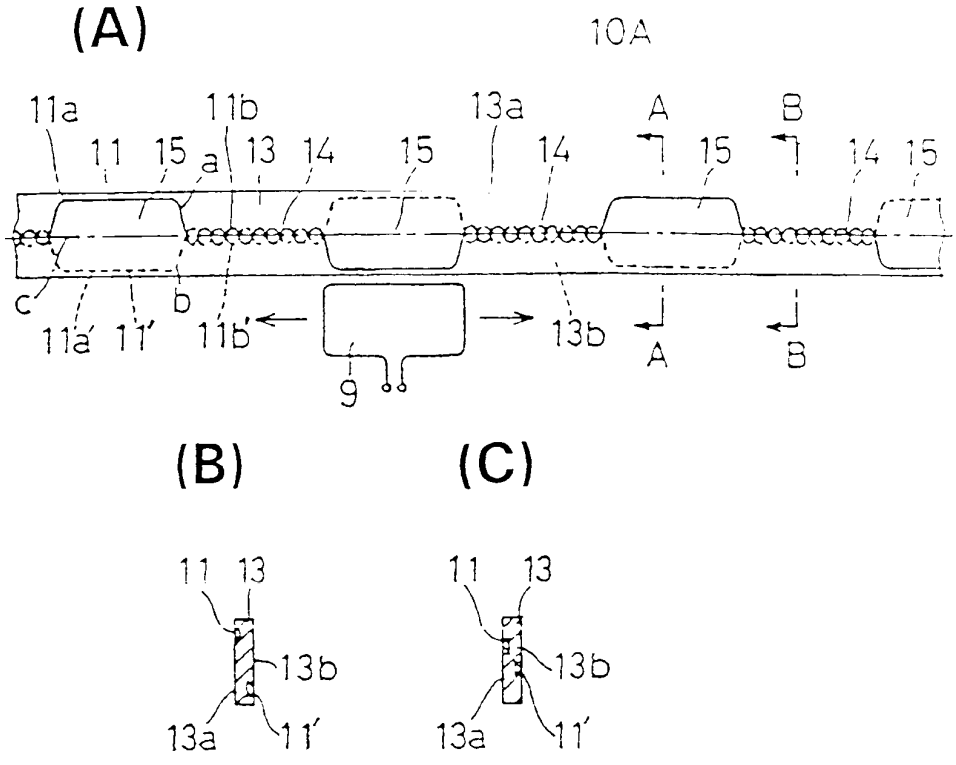

(A)
10A
11a
11b
13a
A
B
11
15
a
13
14
15
14
15
14
15
c
b
11a'
11'
11b'
13b
A
B
9
(B)
(C)
11
13
13b
13a
11'
11
13
13b
13a
11'

FIG. 2

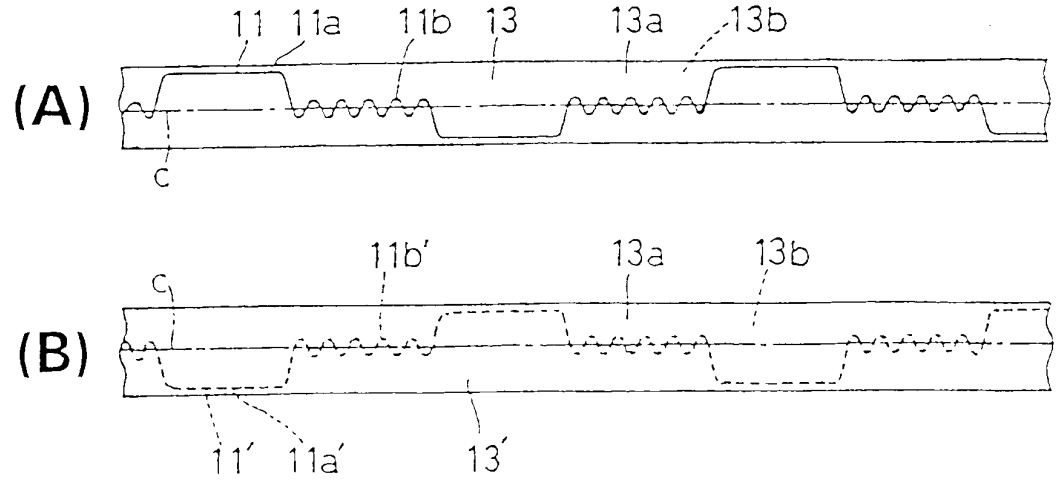

(A)
11
11a
11b
13
13a
13b
c
(B)
c
11b'
13a
13b
11'
11a'
13'

FIG. 3

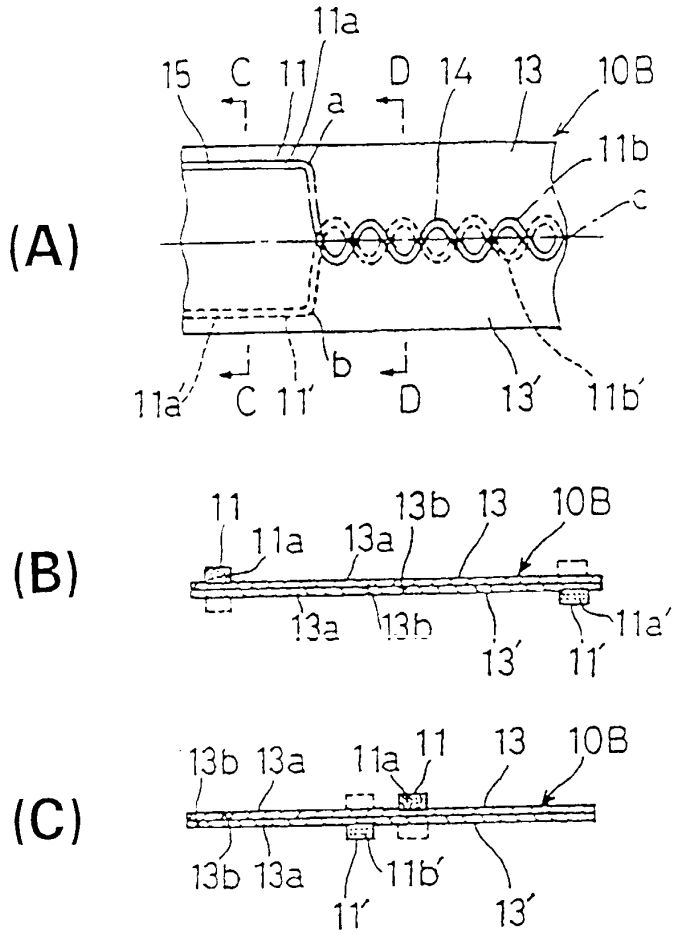

(A)
11a
15
C
11
a
D
14
13
10B
11b
c
11a'
C
11'
b
D
13'
11b'
(B)
11
13b
13
10B
11a
13a
13a
13b
11a'
13'
11'
(C)
13b
13a
11a
11
13
10B
13b
13a
11b'
11'
13'

FIG. 4

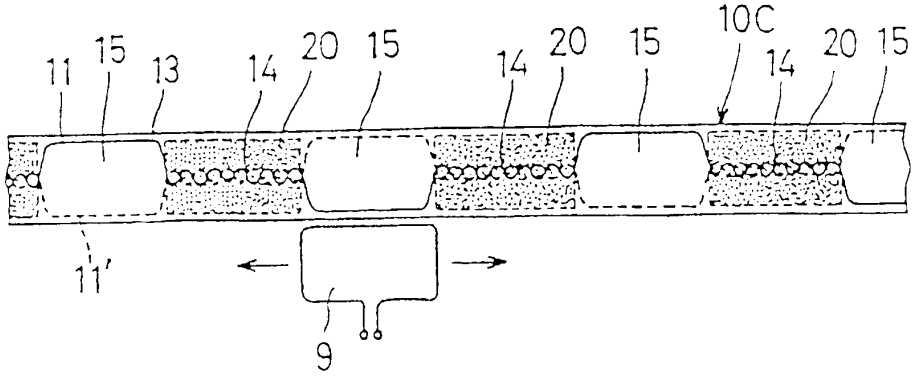

11
15
13
14
20
15
14
20
15
10C
14
20
15
11'
9

FIG. 5

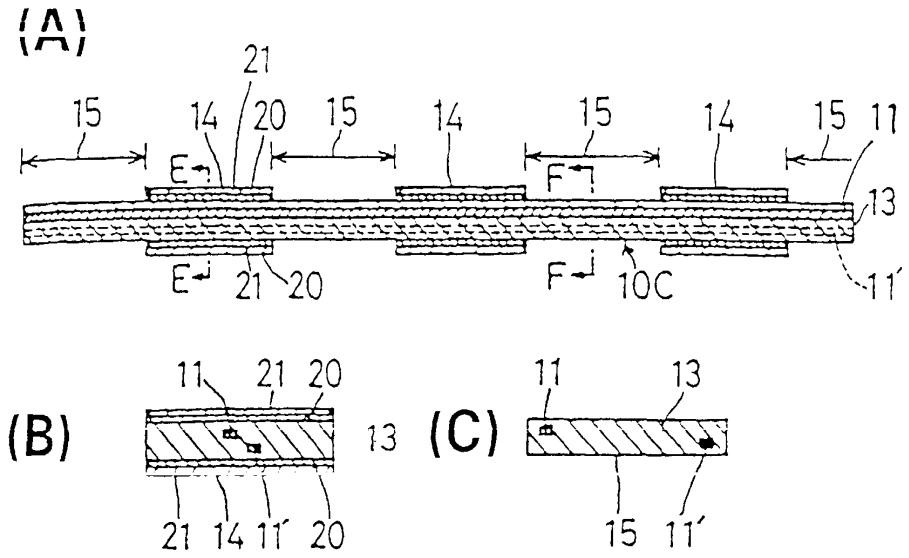

(A)
21
15
14
20
15
14
15
14
15
11
E
F
13
E
21
20
F
10C
11'
(B)
11
21
20
13
21
14
11'
20
(C)
11
13
15
11'

FIG. 6

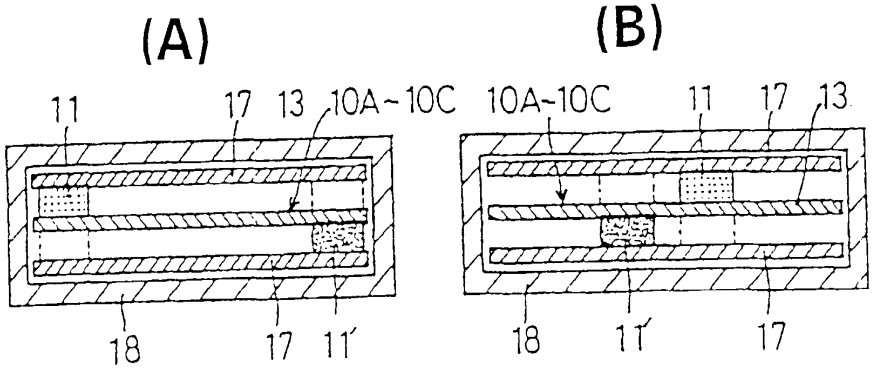

(A)
(B)
11
17
13
10A~10C
10A~10C
11
17
13
18
17
11'
18
11'
17

FIG. 7

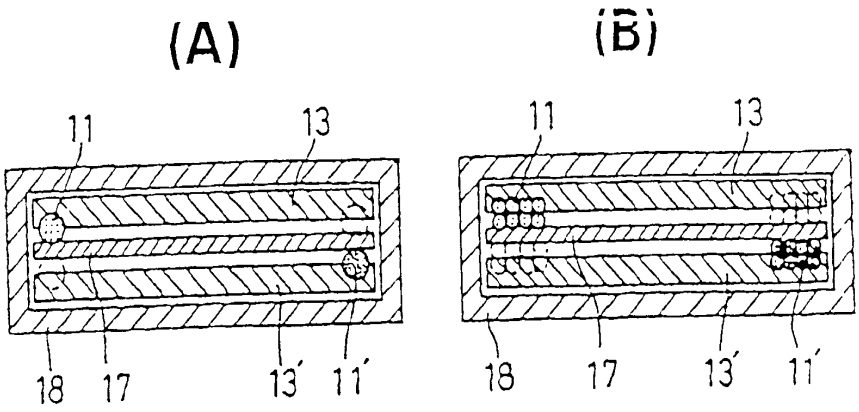


FIG. 8

PRIOR ART

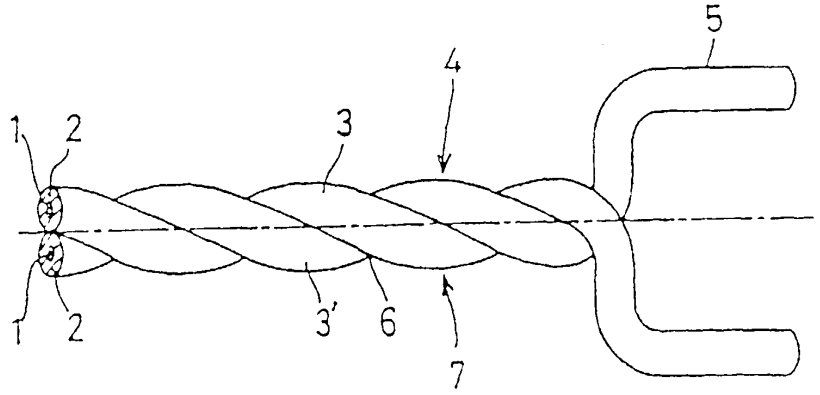


FIG. 9

PRIOR ART

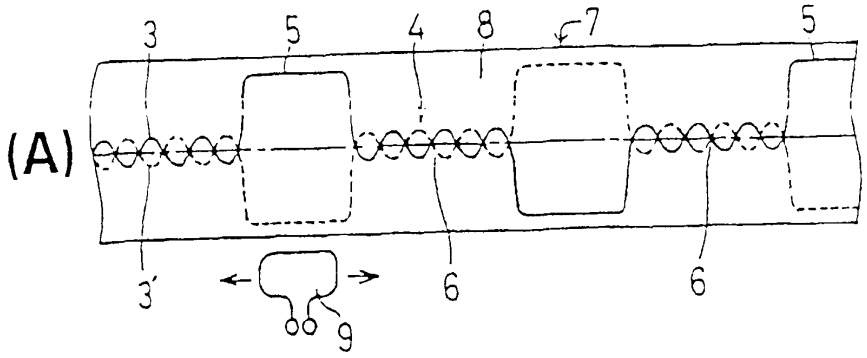


FIG. 10

PRIOR ART